EECS C145B / BioE C165 Spring 2003:
Problem Set II
Due February 28 2003

Please read the sections describing the rules for working in groups and the grading policy in the course introduction handout.

Show all code and plots.

Problem 1 (80 points)

1. Download the image at:

   `http://muti.lbl.gov/145b/images/retroanon.jpg`

   Either use a web browser to do this, or on some Unix systems you can simply type:

   `wget http://muti.lbl.gov/145b/images/retroanon.jpg`

2. Crop the image so that only the photograph remains. You can either use *imcrop* in interactive mode, or use *ginput* and crop the image manually using the coordinates returned by this function.

3. Convert the image to grayscale. Plot the image and print it out. Do not use pseudocolor.

4. Using *imhist*, find and plot the image histogram using *bar*. Use 256 histogram bins. What should the x and y axis labels be? Print the histogram.

5. Are all of the gray levels of the image efficiently used? How could you tell this just looking at the photo?

6. Using *histeq*, equalize the histogram of the image. Plot and print the equalized image.

7. Using *imhist*, find and plot the histogram of the equalized image. Use 256 histogram bins. Print the histogram.

8. Briefly compare the two images in a qualitative sense.

9. Write the equalized image to a jpeg file called "retroanoneq_mine.jpg" using the *imwrite* function.

10. Threshold the equalized image near the middle grayscale value so that all levels above this level are mapped to "white". Use the *find* function to do this. Print the thresholded image.

Problem 2 (80 points)

1. Download

   `http://muti.lbl.gov/145b/images/retroanoneq.jpg`

   This is the equalized image you should have obtained in Problem 1 before thresholding.

2. Generate a 21×21 low-pass Gaussian filter in the space domain. Apply it to the image.

3. Change it into a high-pass filter. Apply it to the original image. Equalize the image for display purposes only, and plot the image. Print the image.

4. Subtract the result of low-pass filtering from the original image. Plot the result after histogram equalization. Print this image.

5. If you were developing a commercial image processing package for use by graphic artists, what would *you* call this special effect?

Problem 3 (70 points + 15 bonus)

1. Load the file:

   `http://muti.lbl.gov/145b/images/retroanoneq.jpg`

2. Using *imresize*, reduce the image size by half. The new image will contain a quarter of the number of pixels in the original image.

3. Design a filter in the frequency domain that will sharpen vertical edges much more than horizontal edges. To earn the bonus points, you need to explain your design process, even if it's by trial-and-error.

4. Apply this filter to the image and plot the results in such a way that your plot verifies the effectiveness of your filter.

5. Add the result to the original image. Plot and print the image. Vertical edges should be clearly enhanced.

Problem 4 (70 points + 15 bonus)

1. Add a sinusoid to the image:

   `http://muti.lbl.gov/145b/images/retroanoneq.jpg`

   after it has been reduced to a quarter of its size. The true width of this image is 1 meter. The frequency of the sinusoid is 22 cycles / m at a direction of -30 degrees relative to the x axis. Its amplitude is 45. Plot this image.

2. Add to this new image another sinusoid of the same frequency and amplitude that travels along the y axis. Plot this image. Find its log magnitude spectrum.

3. Design a notch filter to remove the second sinusoid from the image, without significantly disturbing the first sinusoid. Try to minimize damage to image detail.

4. Plot the filtered result. Label axes using the correct units.

Hint: The function *ginput* is useful for finding the coordinates of points in a plot.